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(54) Abstract Title
Shadow mask for cathode ray tube

(57) A tensioned shadow mask for a cathode ray tube having apertures 52 in the form of slits separated by bridges or tie bars 54 and strips 53. The apertures have internal protrusions or dummy bridges 55 which extend between adjacent strips and face each other but do not connect with each other. The area of one of the dummy bridges may be in the range 70-130% the area of the bridges 54.

FIG. 7

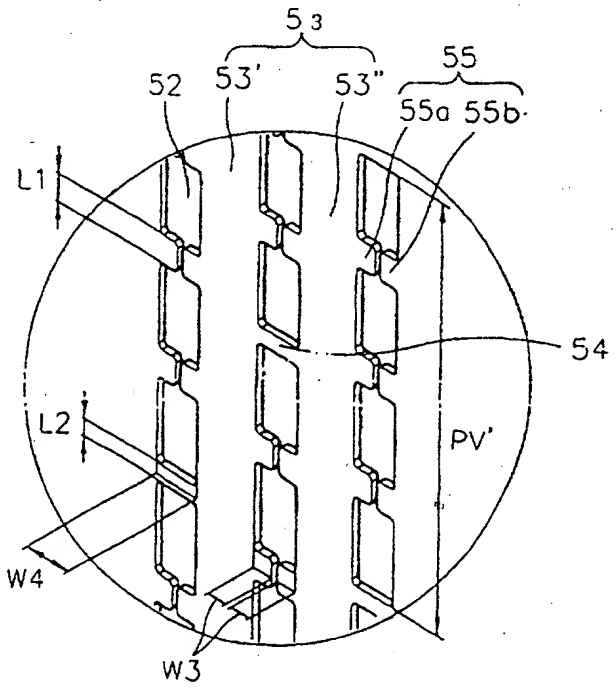

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FIG. 1 (PRIOR ART)

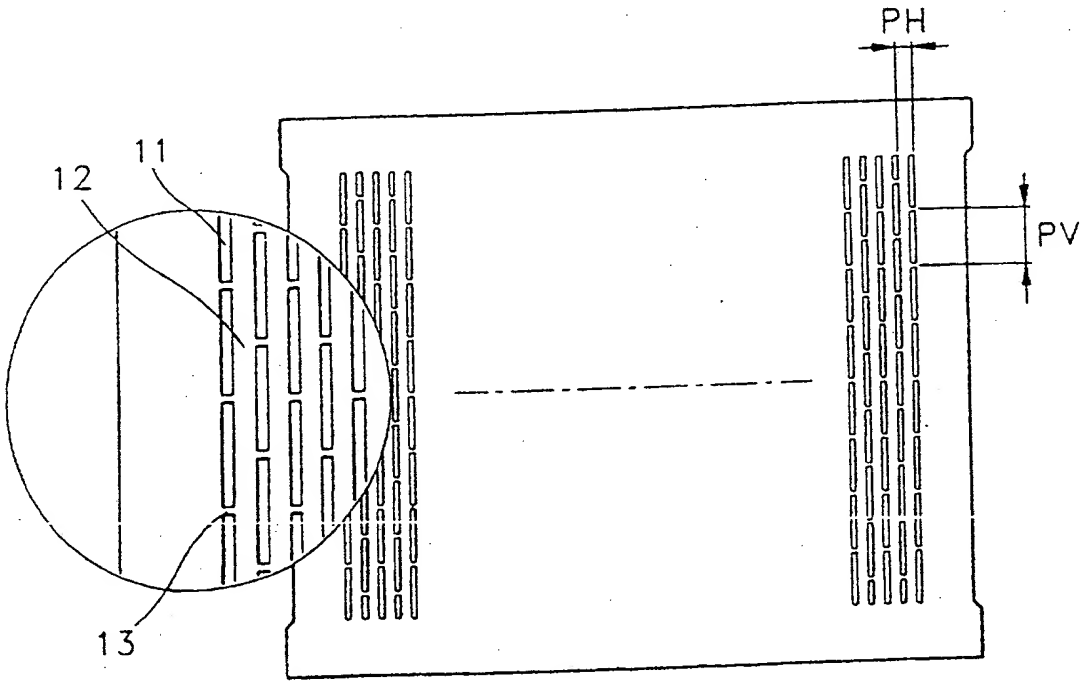


FIG. 2 (PRIOR ART)

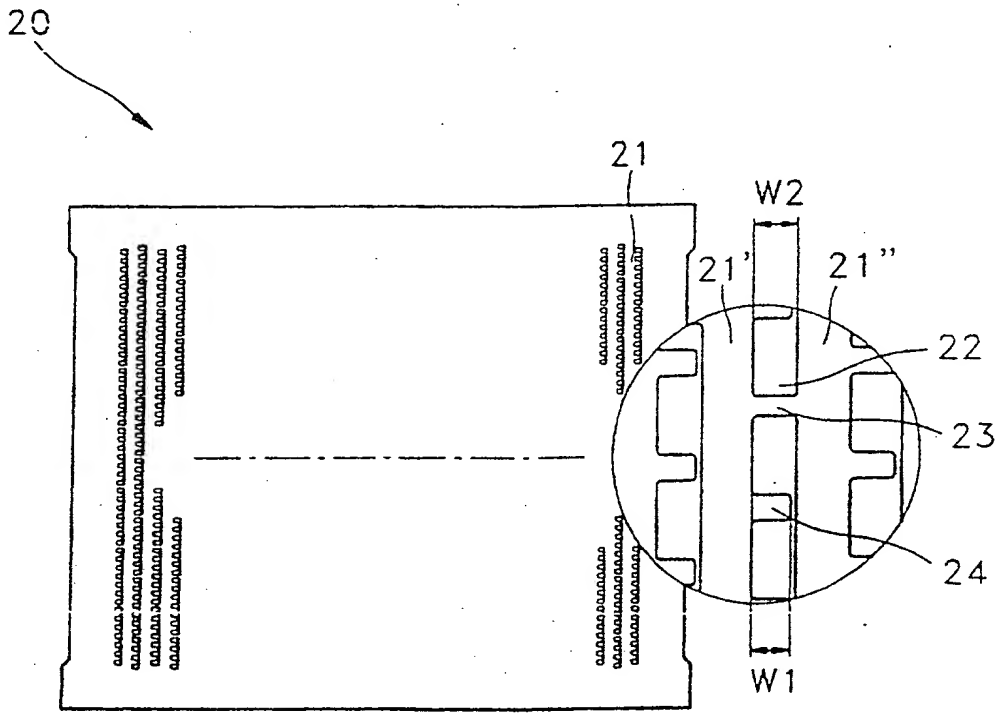


FIG. 3

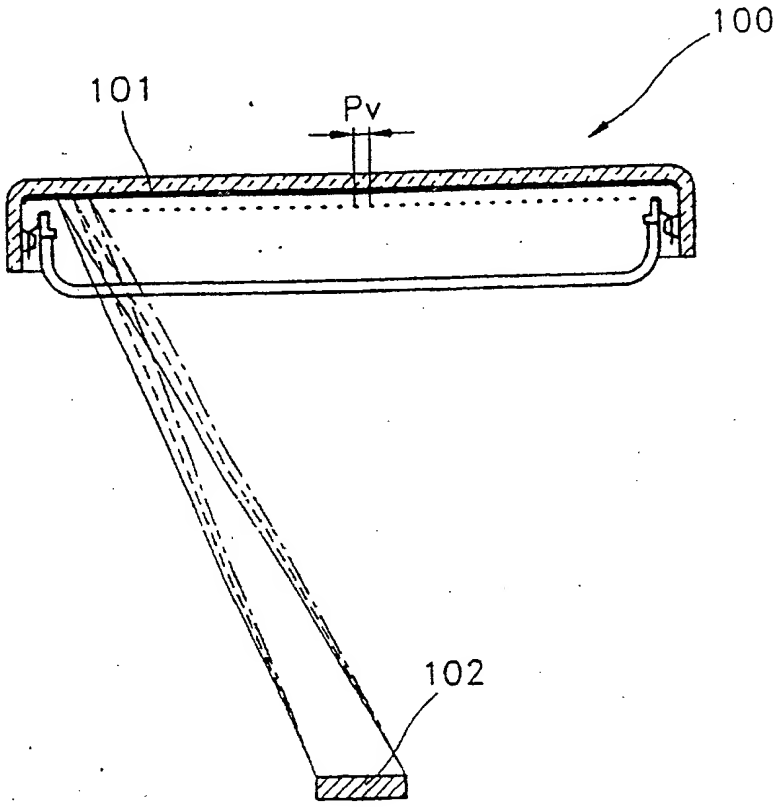


FIG. 4 (PRIOR ART)

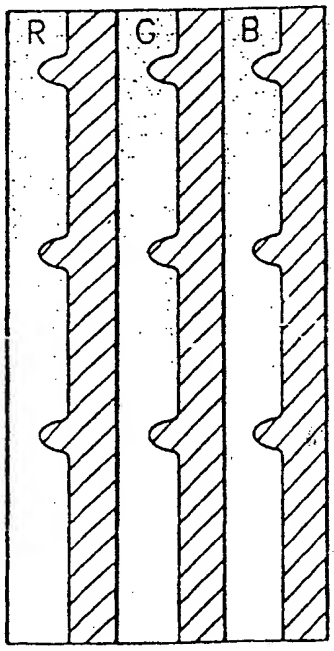


FIG .5

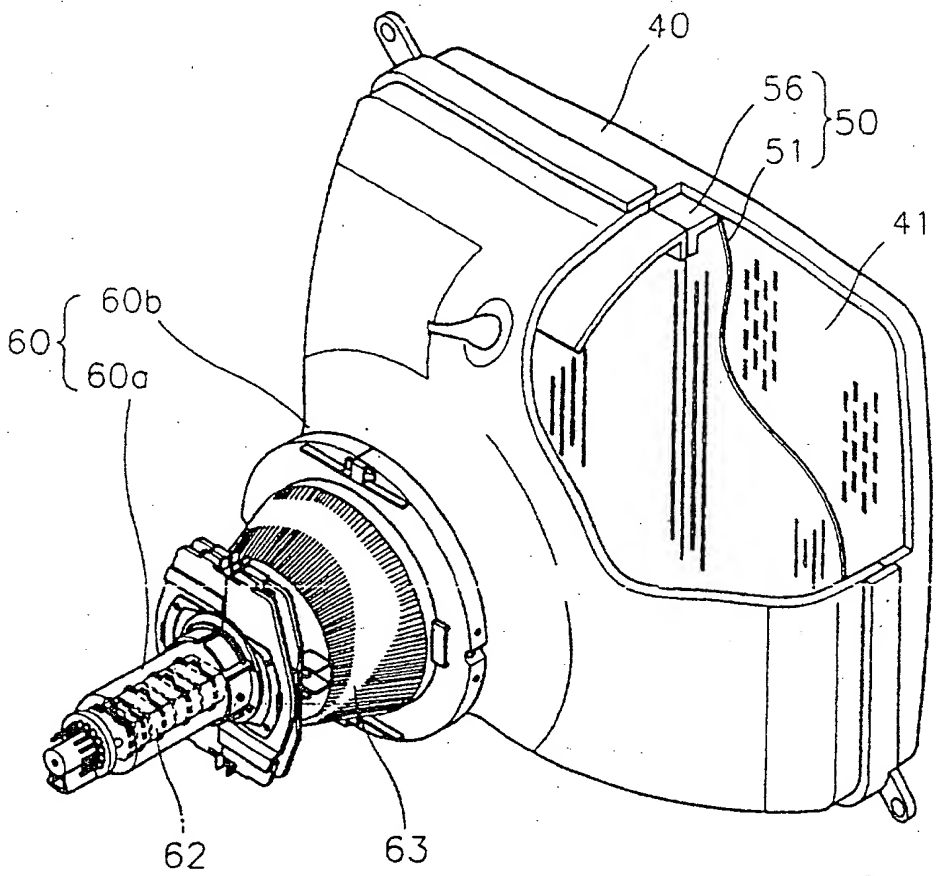


FIG. 6

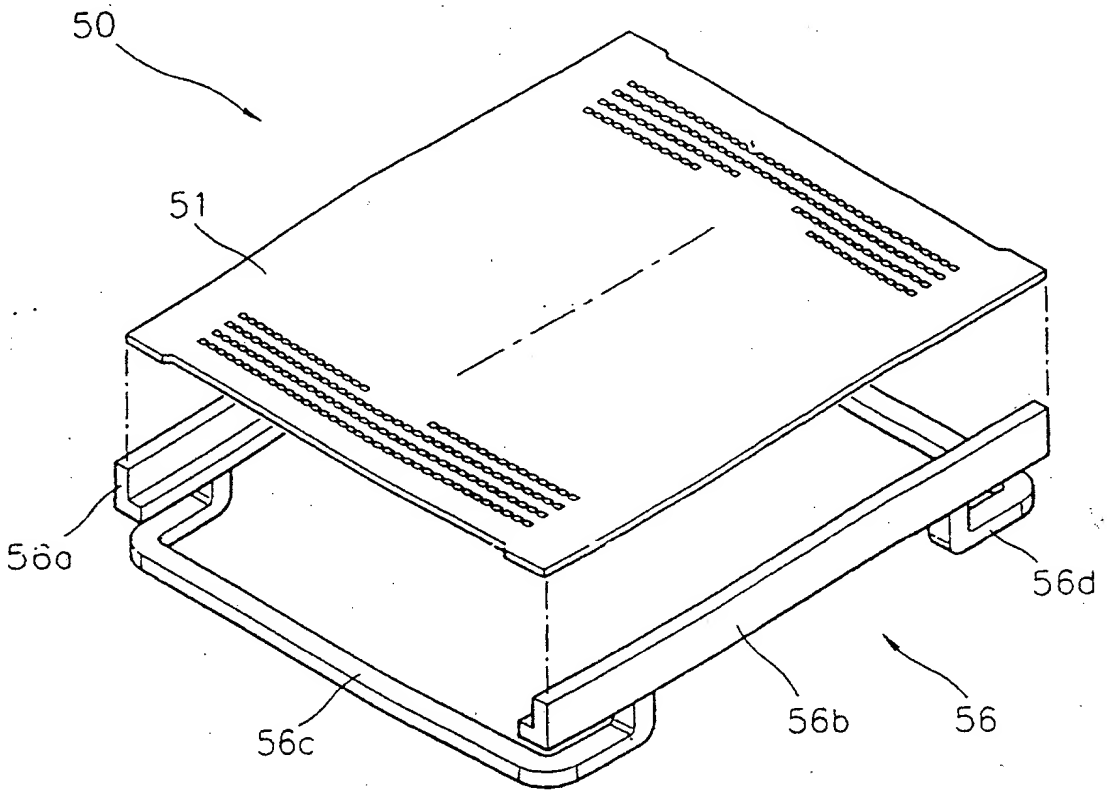


FIG. 7

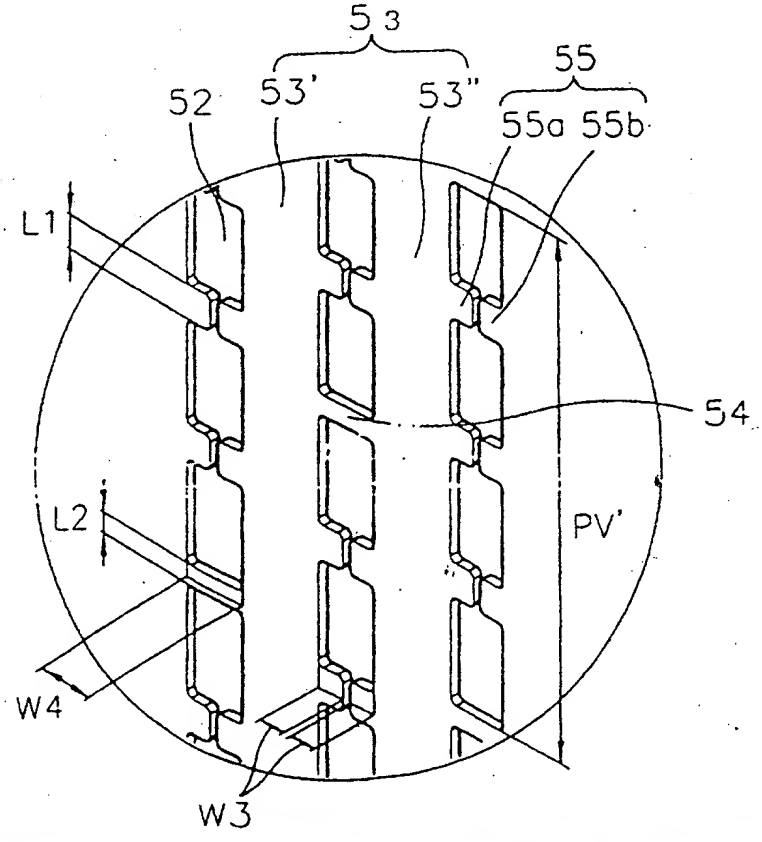


FIG. 8

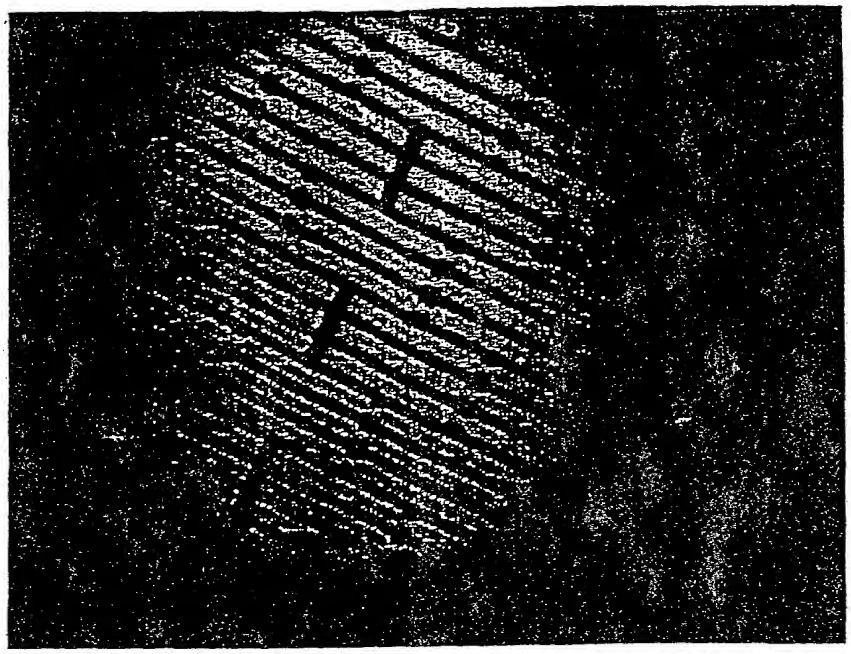


FIG. 9

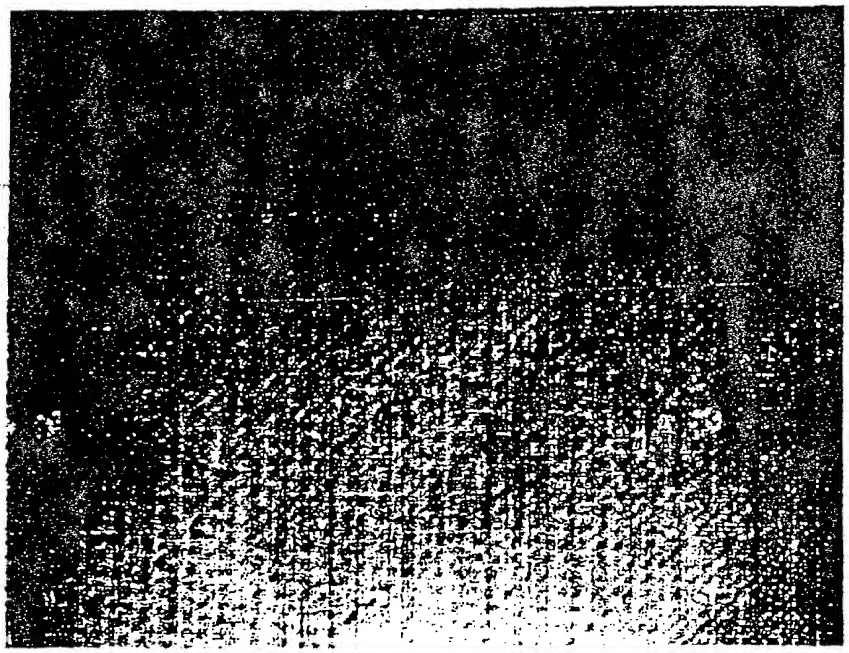


FIG. 10

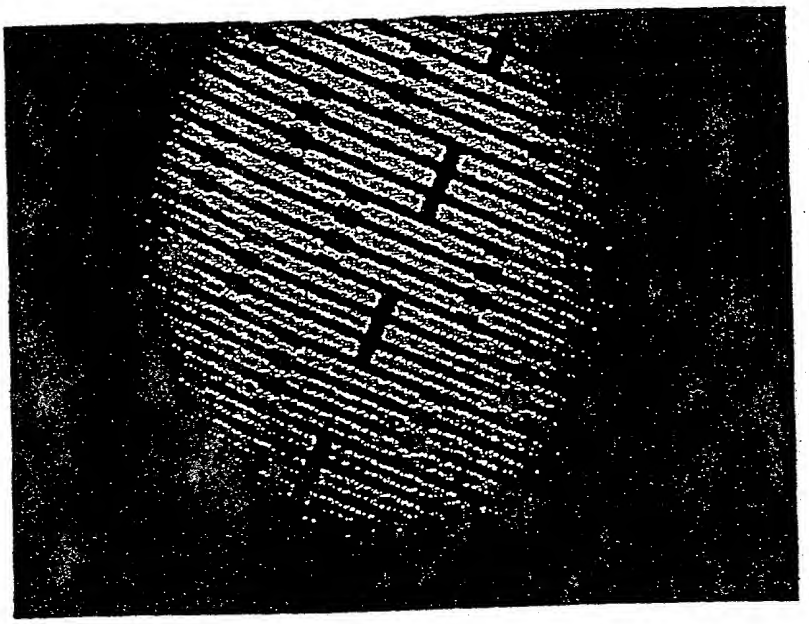


FIG. 11

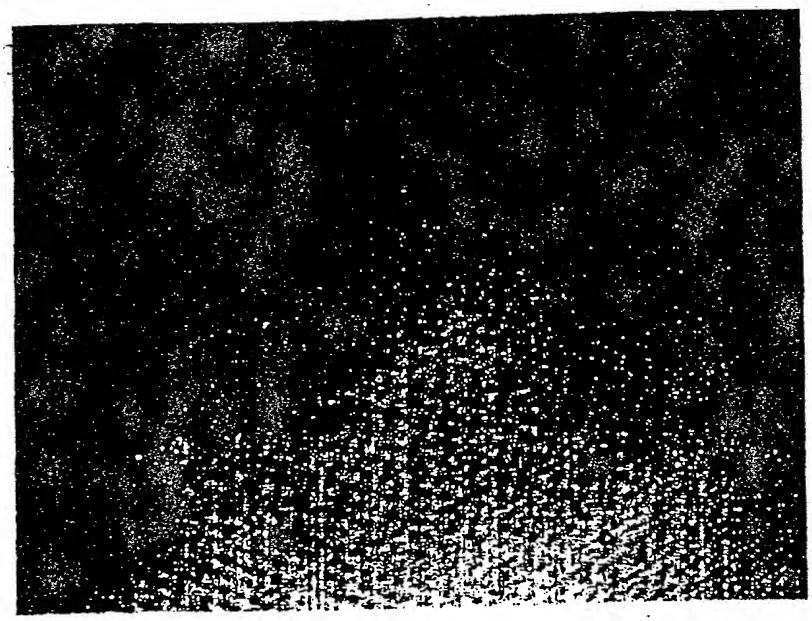


FIG. 12

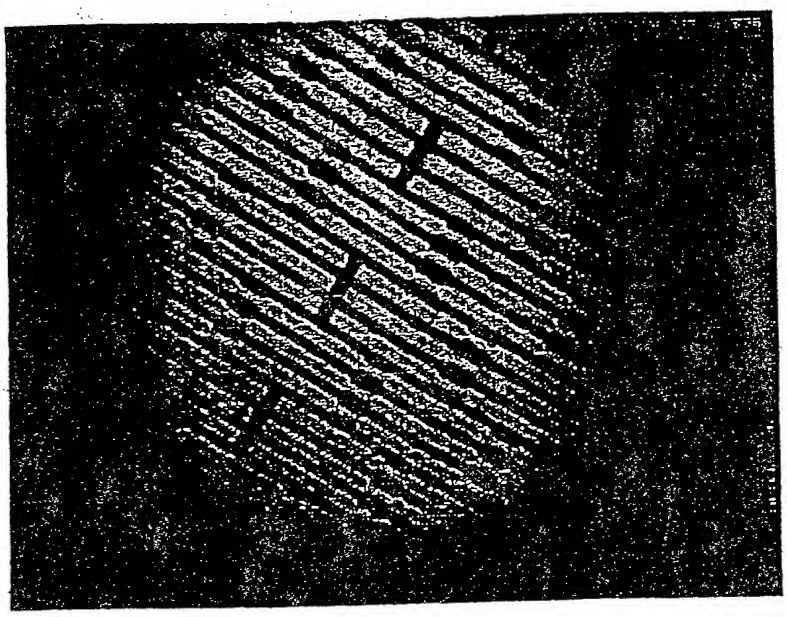


FIG. 13

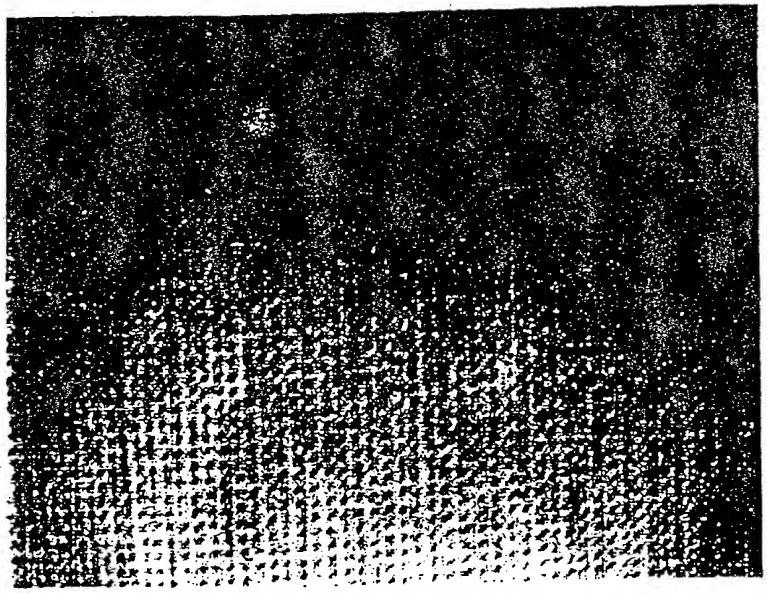


FIG. 14

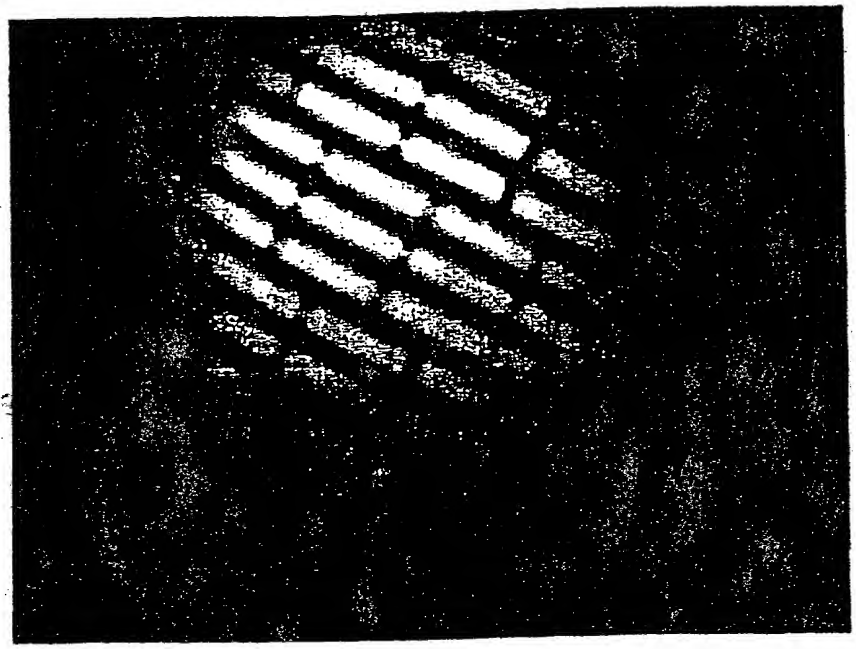


FIG. 15

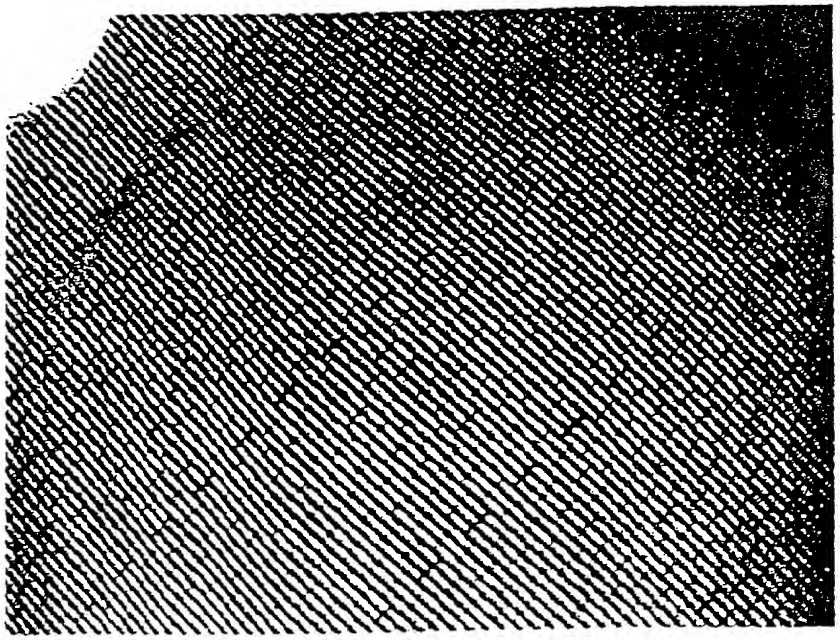


FIG. 16

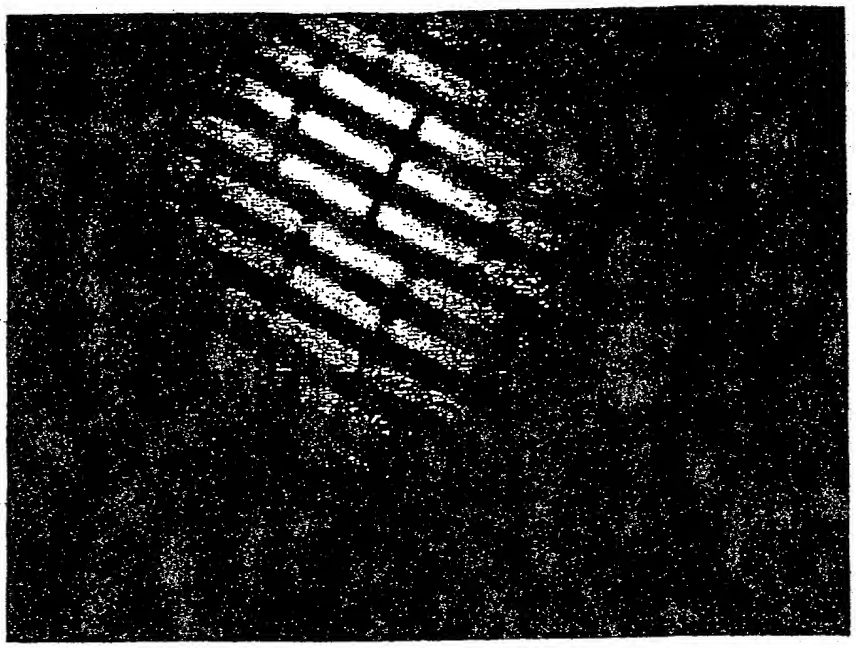
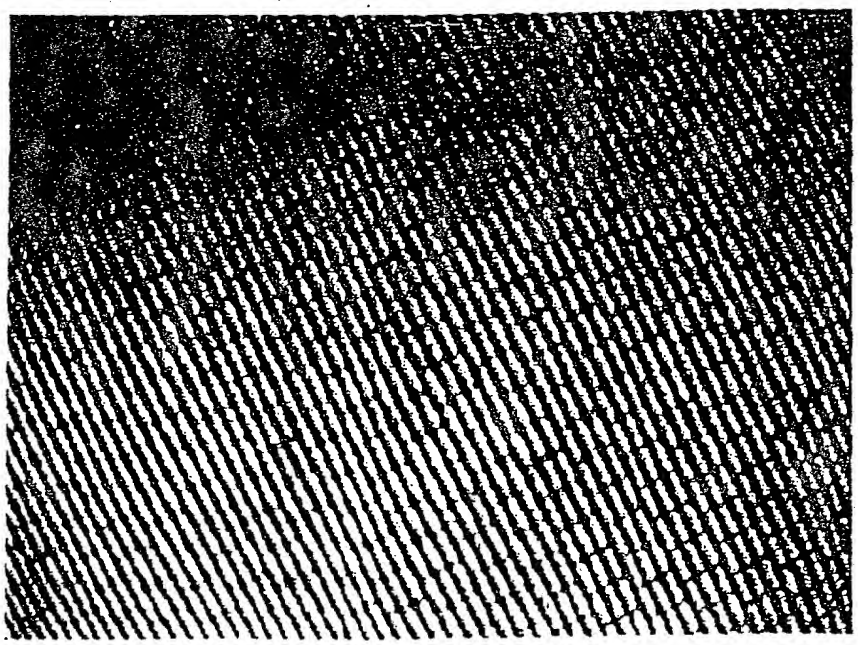


FIG. 17



TENSIONED SHADOW MASK AND COLOUR CATHODE RAY TUBE ADOPTING THE SAME

The present invention relates to a color cathode ray tube (CRT), and more particularly, to a tensioned shadow mask with a color selection function, which has dummy bridges with an improved structure, and a color CRT adopting the same.

Color CRTs for televisions and computer displays employ a shadow mask (hereinafter, simply referred to as a mask) for accurately landing three electron beams emitted from an electron gun onto each phosphor of a phosphor screen. The mask includes; a dot mask with substantially circular apertures; a slot mask with parallel elongated apertures, and a tensioned mask to which tension is applied from the opposite sides thereof, and has a series of parallel strips separated by slits through which electron beams pass.

Figure 1 shows an example of a tensioned mask. As shown in Figure 1, the tensioned mask formed of a foil includes a plurality of strips 12 separated by slits 11 having a predetermined interval, and a plurality of tie bars 13 which interconnect the adjacent strips to define the slits 11 at predetermined intervals.

In the mask, the tie bars 13 which interconnect the adjacent strips 12 can reduce a howling phenomenon, which occurs due to mask vibration by external impact, and unacceptable Poisson's contraction. However, if the vertical pitch PV of the tie bars 23 is too large, that is, if the vertical pitch PV of the tie bars 23 is twice or more the horizontal pitch PH thereof, a reflection image of the tie bars 13 is shown on the screen, which is unpleasant to viewers.

To avoid this problem, US Patent No. 4,926,089 discloses a tensioned mask as shown Figure 2. As shown Figure 2, a tensioned mask 20 includes a plurality of strips 21 separated by slits 22 having a predetermined interval, and tie bars 23 which interconnect the adjacent strips 21. Also, dummy bridges 24, which extends partially between but not interconnecting adjacent strips, are disposed between the adjacent tie bars 23 to separate each slit 21 into sub-slits having a predetermined interval.

In the tensioned mask, due to a technical problem in mask pattern formation, the width W1 of the dummy bridges 24 is smaller than the width W2 of the tie bars 23. Thus, the reflection images by the dummy bridges 24 and the tie bars 23 have a slight

difference in intensity of light. This difference raises the problem of tie bar visibility, thus deteriorating display image and making viewers unpleasant.

In formation of the phosphor screen on the inner side of a faceplate, as shown in Figure 3, a tensioned mask and frame assembly is secured to a faceplate 100, and then subjected to an exposure process for forming a phosphor screen 101, wherein an exposure lamp 102 for use in the exposure process is long enough to irradiate a region corresponding to the vertical pitch between adjacent tie bars 23 or that of adjacent dummy bridges 24 of the tensioned mask 20. However, in the phosphor screen formation using the exposure lamp 102, red phosphor, blue phosphor and green phosphor are not completely excited, resulting in black matrix pattens in the nonexcited regions, as shown in Figure 4. This problem is associated with the offset configureuration of the dummy bridges 24 of the tensioned mask 20. In particular, as shown in Figure 2, the dummy bridges 24 of the tensioned mask 20 extend from a strip 21′ toward the adjacent strip 21″, to define gaps near the strip 21″. Accordingly, regions of the phosphor patterns that correspond to the offset protrusions of the dummy bridges 24, except for regions that correspond to the gaps between the dummy bridges 24 and the strip 21″, are not excited by the electron beams emitted from the electron gun, so that the black matrix remains therein. Such intrusion of the black matrix into the red, blue and green phosphor patterns reduces the emission area of the phosphors, and regions, which are not excited due to the dummy bridges 24 are also shown in a screen, thereby lowering appearance uniformity.

The present invention seeks to provide a tensioned shadow mask and a color cathode ray tube (CRT) adopting the same, capable of eliminating intrusion of a black matrix into phosphor patterns during phosphor screen formation, due to dummy bridges.

The present invention also seeks to provide a tensioned mask and a color CRT adopting the same, capable of eliminating the problem of tie bar visibility.

According to an aspect of the present invention, there is provided a tensioned shadow mask for a cathode ray tube (CRT), comprising: a series of parallel strips separated by slits having a predetermined interval; a plurality of tie bars interconnecting adjacent strips to define a plurality of slits at predetermined intervals; and a plurality of dummy bridges disposed between adjacent tie bars, the dummy bridges having first and second protrusions extending between the adjacent strips and facing each other, but not interconnecting the adjacent strips.

Preferably, the area of the dummy bridges is equal to that of the tie bars, or the area difference between the dummy bridges and the tie bars is in a predetermined range.

According to another aspect of the present invention, there is provided a color cathode ray tube (CRT) including a faceplate having on the inner side thereof a phosphor screen, a tensioned mask and frame assembly secured into the faceplate, which is an assembly of a tensioned mask and a frame, a funnel connected to the faceplate, the funnel having a neck portion and a cone portion, an electron gun inserted in the neck portion of the funnel, and a deflection yoke installed in the cone portion of the funnel, wherein the tensioned mask comprises: a series of parallel strips separated by slits having a predetermined interval; a plurality of tie bars interconnecting adjacent strips to define a plurality of slits at predetermined intervals; and a plurality of dummy bridges disposed between adjacent tie bars, the dummy bridges extending between the adjacent strips and facing each other, but not interconnecting the adjacent strips.

Examples pf the present invention will now be described in detail, with reference to the accompanying drawings in which:

Figure 1 is a plan view of a conventional tensioned mask for a color cathode ray tube (CRT);

Figure 2 is a plan view of another conventional tensioned mask for a color CRT;

Figure 3 is a diagram illustrating an exposure process in a state where a tensioned mask is secured into a faceplate;

Figure 4 shows phosphor patterns obtained by exposing a phosphor screen using the tensioned mask of Figure 2;

Figure 5 is a perspective view of a color CRT according to the present invention;

Figure 6 is an exploded perspective view showing a state where a tensioned mask according to the present invention is secured to a frame;

Figure 7 is a partial enlarged view of the tensioned mask of Figure 6, illustrating an aperture configureuration thereof; and

Figures 8 and 17 are photos illustrating the visibility of tie bars reflected on a phosphor screen with respect to the area difference between the tie bars and dummy bridges of tensioned masks.

As shown in Figure 5, a general color cathode ray tube (CRT) includes a faceplate 40 having on the inner side thereof a phosphor screen 41 with a predetermined pattern, a tensioned mask and frame assembly 50 secured into the faceplate 40, which is an

assembly of a tensioned mask 51 and a frame 56, a funnel 60 connected to the faceplate 40, which has a neck portion 60a and a cone portion 60b, an electron gun 62 inserted in the neck portion 60a of the funnel 60, for emitting electron beams through apertures of the tensioned mask 51 to excite the phosphor screen 41, and a deflection yoke 63 surrounding the cone portion 60b and the neck portion 60a of the funnel 60, for deflecting the electron beams emitted from the electron gun 62.

In particular, in the phosphor screen 41 disposed on the inner side of the faceplate 40, phosphors of red, blue and green colors are deposited in a dotted or striped shape. The tensioned mask and frame assembly 50, as shown in Figure 6, includes the tensioned mask 51 having apertures through which electron beams emitted from the electron gun 62 pass, and the frame 56 for supporting the tensioned mask 51 in tension.

As shown in Figure 7, in the tensioned mask 51, which is formed of a 50-100 μm-thick foil, a series of strips 53 having a width of 190 μm are separated by slits 52 having a predetermined interval. The slits 52 are separated by tie bars 54 which interconnect adjacent strips 53′ and 53″ and have a relatively large vertical pitch PV′, compared to dummy bridges. Also, a plurality of dummy bridges 55, which define the slits 52 at predetermined intervals, are disposed between the tie bars 43, wherein the dummy bridges 55 extend between but not interconnecting adjacent strips.

In particular, the dummy bridges 55, which define the slits 52 at predetermined intervals, include first and second protrusions 55a and 55b which extend between the adjacent strips 53′ and 53″ and face each other, wherein the first and second protrusions 55a and 55b do not contact each other.

In the present embodiment, preferably, the length L1 of the dummy bridges 55 is greater than the length L2 of the tie bars 54. For example, the length L1 of the dummy bridges 55, i.e., the width in the direction of the strips 53, may be in the range of 100 to 120 μm, and the length L2 of the tie bars 54 may be in the range of 55 to 90 μm. Also, the width W3 of the dummy bridges 55 (the sum of the width of the first and second protrusions 55a and 55b) is less than the width W4 of the tie bars 54. Preferably, the area A1 ($=L1\times W3$) of the dummy bridges 55 is equal to the area A2 ($=L2\times W4$) of the tie bars 54, or the area difference between the dummy bridges 55 and the rear tie bars 54 is in a predetermined range. For example, in a mask for monitors, the width W3 of the dummy bridges 55 is 30 μm which is equal to the sum of a width of 15 μm of the first and second protrusions 55a and 55b extending from the adjacent strips 53′ and 53″,

respectively. Also, in a mask for televisions, the width W3 of the dummy bridges 55 is 145 μm which is equal to the sum of a width of 72.5 μm of the ~~first~~ and second protrusions 55a and 55b extending from the adjacent strips 53′ and 53″, respectively. The area of the dummy bridges 55 may differ from that of the tie bars 54. However, it is preferable that the area of the dummy bridges 55 is equal to that of the tie bars 54, so that the tie bars will not visibly stand out. Preferably, the area difference between the dummy bridges 55 and the tie bars 54 is in the range of 30 percent, which is expressed by $|(A1-A2)|/A2 \leq 0.3$.

Also, as shown in Figure 6, the frame 56 of the tensioned mask and frame assembly comprises a pair of supports 56a and 56b spaced a predetermined distance, for supporting the longer side edges of the tensioned mask 51, and a pair of elastic members 56c and 56d for applying tension to the tensioned mask 51, wherein both ends of the elastic members 56c and 56d are fixed to those of the support members 56a and 56b. The frame configureuration is not limited to the above configureuration, and any configureuration capable of acting tension on the tensioned mask 51 can be adopted.

In the color CRT having the configureuration of Figure 5, electron beams emitted from the electron gun 62 inserted into the neck portion 60a of the funnel 60 are selectively diffracted by the deflection yoke 63 according to scanning positions in the phosphor screen, and then land through the slits 52 of the tensioned mask 51 on the phosphor screen, thereby forming an image thereon.

In the color CRT according to the present invention, which forms an image as mentioned above, phosphor patterns are uniformly formed over the phosphor screen, without intrusion of a black matrix into the phosphor patterns, so that the brightness and resolution of the display image are improved. In particular, in order to obtain a phosphor screen, a phosphor of red, green or blue color is deposited on the inner surface of the faceplate 40 on which a black matrix has been deposited, and an exposure process is carried out thereon while the tensioned mask and frame assembly 50 is fixed to the faceplate 40. During the exposure process, the phosphor exposed through the gap between the first and second protrusions 55a and 55b of the dummy bridges 55 can be excited, without causing non-excited regions due to the dummy bridges 55 in the phosphor screen. This is due to the configureuration of the dummy bridges 55, in which the first and second protrusions 55a and 55b extend facing each other between adjacent strips, but not interconnecting the adjacent strips.

During the operation of the color CRT, the phosphors of the phosphor screen 41 cannot be completely excited by the electron beams emitted from the electron gun, due to the tie bars 54 and the dummy bridges 55, which define the slits 52 at predetermined intervals and shield electron beams emitted from the electron gun, thus resulting in a reflection image thereby on the screen. However, since the present invention increases the length L2 of the dummy bridges 55 to be greater than the length L1 of the tie bars 54 such that the area of the dummy bridges 55 is to be almost equal to that of the tie bars 54, the reflection image area due to the tie bars 54, which corresponds to a nonexcited region of the photosphere screen, is similar to that due to the dummy bridges 55. As a result, real image and reflection image are uniformly distributed over the screen, so that viewers scarcely perceives the reflection image, thereby improving appearance uniformity. The reflection image distribution can be controlled by varying the number of tie bars 55 and dummy bridges 54.

Experimental Example 1

The appearance uniformity with respect to the area difference between the tie bars and the dummy bridges was observed by varying the length of the dummy bridges relative to the length of the tie bars in a tensioned mask of a CRT for monitors. The result is shown in Table 1.

Table 1

Sample	Tie bar			Dummy bridge			Area ratio (%)	Appearance Uniformity
	Length (μm)	Width (μm)	Area (μm^2)	Length (μm)	Width (μm)	Area (μm^2)		
1	60	60	3,600	60	30	1,800	50	poor
2	60	60	3,600	90	30	1,800	75	moderate
3	60	60	3,600	120	30	1,800	100	good
4	60	60	3,600	150	30	1,800	125	moderate

As can be noted from Table 1, the appearance uniformity is acceptable when the area of the tie bars is in an range greater than 70% and less than 130% of the area of the tie bars.

Figures 8 through 13 are photos illustrating the visibility of tie bars reflected on the phosphor screen, with respect to the area difference between the tie bars and dummy bridges of tensioned masks shown in Table 1. In particular, Figure 9 is a macro photo in a case when the area of the dummy bridges is 50% of that of the tie bars (Sample 1 of Table 1), and Figure 8 is a 20X-magnified photo of Figure. 9. As shown in Figures 8 and 9, distinct tie bar shadows appear on the phosphor screen.

Figure 11 is a macro photo showing the tie bar visibility on the phosphor screen when the area of the dummy bridges is 75% of that of the tie bar (Sample 2 of Table 1), and Figure 10 is a 20X-magnified photo of Figure 11. As shown in Figure 10, the sizes of the reflection image by the tie bars and the dummy bridges appears to be equal to each other, showing a slight difference in intensity of light therebetween. Also, as shown in Figure 11, it is difficult to distinguish the tie bar shadows on the phosphor screen from the dummy bridges shadows thereon.

Figure 13 is a macro photo showing the tie bar visibility on the phosphor screen when there is no difference in area between the tie bars and the dummy bridges (Sample 3 of Table 1), and Figure 12 is a 20X-magnified photo of Figure 13. In Figure 12, the dummy bridges that are enlarged in the longitudinal direction so as to make the area of the dummy bridges equal to that of the tie bars are visible. As shown in Figure 13, it is difficult to distinguish the tie bar shadows from the dummy bridges shadows, and the reflection images of the tie bars and dummy bridges show uniform intensity of light.

Although the photos of the Sample 4 in Table 1, in which the area of the dummy bridges is 125% of that of the tie bars, were not taken, the size of the reflection image of the dummy bridges on the phosphor screen was large whereas that of the tie bars was small, compared to the Sample 3. Furthermore, the reflection image of the tie bars were shown as white dots on the screen.

Experimental Example 2

The appearance uniformity with respect to the area difference between the tie bars and the dummy bridges was observed by varying the length of the dummy bridges relative to the length of the tie bars in a tensioned mask of a CRT for televisions. The result is shown in Table 2.

Table 2

Sample	Tie bar			Dummy bridge			Area ratio (%)	Appearance Uniformity
	Length (μm)	Width (μm)	Area (μm^2)	Length (μm)	Width (μm)	Area (μm^2)		
1	80	195	15,600	60	145	8,700	55	poor
2	80	195	15,600	80	145	11,600	74	moderate
3	80	195	15,600	108	145	15,660	100.3	good
4	80	195	15,600	140	145	20,300	130.1	moderate

As can be understood from Table 2, the appearance uniformity is acceptable when the area difference between the tie bars and dummy bridges is in the range of 30%.

Figures 14 through 17 are photos illustrating the visibility of tie bars reflected on the phosphor screen, with respect to the area difference between the tie bars and dummy bridges of tensioned masks shown in Table 2. In particular, Figure 15 is a macro photo in a case when the area of the dummy bridges is 55% of that of the tie bars (Sample 1 of Table 2), and Figure 14 is a 20X-magnified photo of Figure 15. As shown in Figures 14 and 15, although the resolution is poor, due to the large horizontal pitches of the phosphor pattern and the slit of the tensioned mask for televisions, compared to those for monitors (Experimental Example 1), distinct tie bar shadows appear on the screen.

Figure 17 is a macro photo showing the tie bar visibility on the phosphor screen when the area of the dummy bridges is 74% of that of the tie bars (Sample 2 of Table 2), and Figure 16 is a 20X-magnified photo of Figure 17. In Figure 16, the dummy bridges that are enlarged in the longitudinal direction so as to make the area of the dummy bridges equal to that of the tie bars are distinct. As shown in Figure 17, the reflection images of the tie bars and dummy tie bars have uniform intensity of light, so that it is difficult to distinguish the reflection image of the tie bars from that of the dummy tie bars, thus improving the appearance uniformity.

Although the photos of the Sample 4 in Table 2, in which the area of the dummy bridges is 130% or more larger then that of the tie bars, were not taken, the size of the reflection image of the dummy bridges on the phosphor screen was large whereas that of the tie bars was small, compared to the samples described with reference to photos. Furthermore, the reflection image of the tie bars was shown as white dots on the screen.

Claims:

1. A tensioned shadow mask for a cathode ray tube (CRT), comprising:

a series of parallel strips separated by slits having a predetermined interval;

a plurality of tie bars interconnecting adjacent strips to define a plurality of slits at predetermined intervals; and

a plurality of dummy bridges disposed between adjacent tie bars, the dummy bridges having first and second protrusions extending between the adjacent strips and facing each other, but not interconnecting the adjacent strips.

2. A tensioned shadow mask as claimed in claim 1, wherein the width of the first protrusions is the same as the width of the second protrusions, such that the gaps between the first and second protrusions are located at the center of the slits.

3. A tensioned shadow mask as claimed in claim 1 or 2, wherein the area of one of the dummy bridges is in an range greater than 70% and less than 130% of the area of one of the tie bars.

4. A colour cathode ray tube (CRT) including a faceplate having on the inner side thereof a phosphor screen, a tensioned mask and frame assembly secured into the faceplate, which is an assembly of a tensioned mask and a frame, a funnel connected to the faceplate, the funnel having a neck portion and a cone portion, an electron gun inserted in the neck portion of the funnel, and a deflection yoke installed in the cone portion of the funnel, wherein the tensioned mask comprises:

a series of parallel strips separated by slits having a predetermined interval;

a plurality of tie bars interconnecting adjacent strips to define a plurality of slits at predetermined intervals; and

a plurality of dummy bridges disposed between adjacent tie bars, the dummy bridges extending between the adjacent strips and facing each other, but not interconnecting the adjacent strips.

5. A colour cathode ray tube as claimed in claim 4, wherein the area of one of the dummy bridges is in an range greater than 70% and less than 130% of the area of one of the tie bars.

6. A tensioned shadow mask for a cathode ray tube as herein described, with reference to the accompanying Figures 5 to 17.

7. A colour cathode ray tube as herein described, with reference to the accompanying Figures 5 to 17.

The Patent Office

INVESTOR IN PEOPLE

Application No:	GB 0007023.5	**Examiner:**	Rachel Foxon
Claims searched:	1-7	**Date of search:**	7 August 2000

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.R): H1D (DAF4)

Int Cl (Ed.7): H01J 29/07, 9/14

Other: Online: WPI, EPODOC, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	EP 0487106	Kabushiki Kaisha Toshiba (see esp fig 3a)	1,2,4
X	US 4926089	Zenith (see whole doc)	1,2,4
X	US 4296189	RCA Corporation (see esp fig 5)	1,2,4

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.